driving the opening/closing member. The trapping is then detected based on a pulse signal from the rotation detecting sensor.

Japanese Patent Laid-Open Publication No. 6-280446 discloses a opening/closing control device that determines the occurrence of trapping when a drive speed and a drive acceleration of the motor is less than a predetermined value, which is determined based on a drive speed and a drive acceleration of the opening/closing member. The opening/closing control device detects the rotation of the motor by a motor position detecting sensor and calculates a motor rotation speed and a motor rotation acceleration. The opening/closing control device performs feedback/reverse control by comparing the motor rotation speed with a speed threshold value when a motor rotation speed change is regular. Alternatively, the opening/closing control device performs reverse control by comparing the motor rotation acceleration with an acceleration threshold value when the motor rotation speed change is not regular. At this time, the speed threshold value and the acceleration threshold value are corrected according to the drive voltage, the sliding resistance of the opening/closing member, and the like.

Rd 12/1/05

However, the following problem arises when the disclosed device is employed in a vehicle. Power is generally supplied to the opening/closing control device (for example, DC: 12V) from a battery in the vehicle. The voltage is thus fluctuated in response to a state of the load connected to the battery. If the motor for actuating the opening/closing member is driven by the battery which voltage is fluctuated, the motor speed is also fluctuated. In the method in which

to be changed and thus the determination timing of the trapping is not delayed when compared to the conventional device. The trapping force can be prevented from increasing due to the delay of the trapping determination. Rd 12/1/05

Further, according to the control means of the CPU 5, the high-pass filter is applied to the difference between the estimated speed being corrected and the actual speed of the motor. When the value after passing through the filter exceeds the predetermined threshold value, the trapping is determined. By performing the high-pass filter on the difference between the estimated speed being corrected and the actual speed of the motor, the offset from 0 point is eliminated, thereby performing the trapping determination with high accuracy and improving the reliability of the trapping detection device.

The principles, preferred embodiment and mode of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. Further, the embodiments described herein are to be regarded as illustrative rather than restrictive. Variations and changes may be made by others, and equivalents employed, without departing from the sprit of the present invention. Accordingly, it is expressly intended that all such variations, changes and equivalents which fall within the spirit and scope of the present invention as defined in the claims, be embraced thereby.

The trapping determination procedure is carried out repeat dly at predetermined time intervals (for example, several ms). At S1, the input operation to the CPU 5 from the motor rotation sensor 7 and the motor drive voltage is performed. In the input operation from the motor drive voltage, the battery voltage at the time is monitored by the CPU 5 through the input I/F 4 since the motor 2 is driven by the battery voltage. The CPU 5 calculates the rotation speed of the motor 2 based on a pulse output such as a sine wave and a rectangular wave from the motor rotation sensor 7. In this case, the rotation speed of the motor 2 is obtained, for example, by a map shown in Fig. 4 indicating the static characteristic that the motor rotation speed is in proportion to the motor drive voltage. In addition, the actual speed of the motor 2 is obtained, for example, by a number of the rising edge and the falling edge of the pulse detected within a predetermined time period. According to the present embodiment, the motor rotation speed is detected by the motor rotation sensor 7. Alternatively, the motor rotation speed may be detected by an optical means using the optical reflection, or an acoustic means using the acoustic reflection. Further, a speed sensor may be employed for directly detecting the rotation status such as the motor rotation number and the motor speed of the motor 2.

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When the motor rotation speed is obtained at S1, then an estimated speed of the motor 2 is calculated at S2. In the calculation of the estimated motor speed, the motor speed is estimated from the motor rotation speed, which is regarded as the estimated motor speed. When the motor rotation speed is predetermined as mv, a terminal voltage on one side is predetermined as Vb, a

predetermined time in S3 desirably corresponds to Ta required for the motor rotation speed to be stabilized after the motor 2 starts being driven. When Ta (for example, several msec) is not elapsed, the motor rotation is not stable and thus the offset correction is not performed.

When the actual speed of the motor 2 detected by the pulse output from the motor rotation sensor 7 is stabilized after the predetermined time from the motor start, a difference err (speed difference) between the actual rotation speed (actual speed) of the motor 2 rmv and the estimated rotation speed (estimated speed) of the motor 2 emv is calculated for being used as the offset correction value Δb (= rmv - emv) (refer to Fig. 5B).

The offset correction value Δb can be obtained at a predetermined time (i.e., one point) at which the speed difference err between the actual speed rmv and the estimated speed emv of the motor 2 is calculated. In addition, if the offset correction value Δb is required with more accuracy, the average value of the speed difference err is obtained during a predetermined time period or a known low-pass filter is applied to the speed difference err obtained in a predetermined time period for eliminating a higher frequency range than a predetermined value. Rel 12/1/05

At S6, a high-pass filter is applied to the estimated speed being corrected for eliminating a lower frequency range than a pred termined value. Then, at S7, the trapping determination is conducted. The trapping is determined based on a difference between the estimated speed being corrected by calculation and

by the speed detection means and the estimated motor speed stored before the predetermined time is calculated, which is used for the correction of the estimated motor speed. The trapping is determined based on the change state (for example, change amount or change rate) of the difference between the estimated motor speed being corrected and the actual motor speed by considering the change of the drive voltage applied to the motor.

The motor rotation speed is estimated based on the motor drive voltage. The estimated speed of the motor is calculated and then corrected based on the difference between the actual speed of the motor and the estimated speed obtained before the predetermined time. Thus, the motor rotation speed can be estimated by considering the change of the motor drive voltage in the case that the motor drive voltage is changed. In addition, the estimated speed obtained by calculation can be corrected based on the difference between the actual motor speed and the estimated motor speed obtained before the predetermined time. Therefore, the correction is performed on the estimated speed obtained in a state in which the motor rotation is stabilized. The accuracy of the estimated motor speed obtained in this way is improved. Accordingly, the accurate trapping determination is possible when the estimated speed is employed in the trapping determination. RJ 12/1 RJ

According to the trapping determination means of the CPU 5, the incident of the trapping can be detected by simply comparing the difference between the estimated speed being corrected and the actual speed and the predetermined threshold value. The threshold value for detecting the trapping does not require 12/1/05 RJ